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The American Association for the Advancement of Science:
Review of Some of the More Recent Advances in the Study of Blood Diseases: PROFESSOR CYRUS C. STURGIS 367

What is a Proof?: PROFESSOR EDWIN B. WILSON 371

Scientific Events:
The New Chair of Astronomy at the Royal Institution; The Stratosphere Balloon; Conference on Spectroscopy at the Massachusetts Institute of Technology; Fellowships of the Charles A. Coffin Foundation 373

Scientific Notes and News 375

Discussion:
The Significance of Food Habits Research in Wild Life Management: DR. PAUL L. ERRINGTON. *Mastodon and Other Remains at Aurora, Illinois:* PROFESSOR CLARENCE R. SMITH. *Longevity in the Box Turtle:* DR. C. I. REED. *Results of Goiter Prophylaxis with Iodized Salt:* DR. J. F. MCCLENDON 378

Societies and Meetings:
The New Orleans Academy of Sciences: PHILIP C. WAKELEY. *The Oklahoma Academy of Science:* DR. HORACE J. HARPER. *The South Carolina Academy of Science:* PROFESSOR J. E. COPENHAVER 381

Scientific Apparatus and Laboratory Methods:
A Commutator for the Harvard Kymograph: PROFESSOR WM. A. HIESTAND. *Meningococcus Precipitating Antigen for Routine Testing of Therapeutic Serums:* LUCY MISHULOW 382

Special Articles:
Investigation of Overthrust Faults by Seismic Methods: DR. JOHN P. BUWALDA and DR. BENO GUTENBERG. *Distribution of Mitochondria in the Foraminiferan Iridia diaphana:* WM. L. DOYLE. *Direct Isolation of Pasteurella-like Microorganisms from Brains of Horses Suffering from So-called Cornstalk Disease:* PROFESSOR ROBERT GRAHAM. *Ergotocin:* PROFESSOR M. S. KHARASCH and R. R. LEGAULT 384

Science News 6

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REVIEW OF SOME OF THE MORE RECENT ADVANCES IN THE STUDY OF BLOOD DISEASES[1]

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PROGRESS in hematology, as in any other science, depends to a great extent upon new and accurate methods of observation. As has been emphasized by Sir Humphry Rolleston,[2] probably the two most important steps which led to a great increase in our knowledge of blood diseases were the introduction of the microscope, and especially the compound, achromatic form by G. D. Amici a hundred years ago, and the development of the modern methods of staining blood by Paul Ehrlich, which he began in 1877.

The entire field of medicine from a scientific standpoint has progressed more rapidly during the past 50 years than it has at any other time in the history of the world. New, valuable and accurate information which has an important bearing on the cause and cure of disease has accumulated so rapidly that those who teach the practice of medicine and are interested in problems of medical research find that it requires a great effort on their part to keep abreast with the advances which are being made, even when their interests are largely restricted to a specialized field.

The science of hematology illustrates as well as any other branch of medicine that these statements are true, for during the past decade many new and fundamental facts have been discovered which have an important bearing upon the etiology and the treatment of certain blood diseases.

As it will be necessary obviously to limit this discussion, it is essential that my remarks be confined to

[1] Address of the vice-president and chairman of the Section of the Medical Sciences, delivered before the General Session, American Association for the Advancement of Science, Pittsburgh, December 27, 1934.

[2] Sir Humphry Rolleston, *Proc. of the Royal Soc. of Med.*, 27: 31–48, July, 1934.

a few outstanding achievements in this field which have been developed recently on a sound scientific basis. I propose to discuss only three phases of hematology in which recent and important contributions have been made to our knowledge. They are: (1) The etiology and treatment of pernicious anemia; (2) the iron-deficiency anemias and their treatment; and (3) the etiology of agranulocytosis.

Pernicious anemia is a disease which was first described by Thomas Addison in 1849, 85 years ago. Until 1926, the following would have been a correct and concise definition of the condition: "It is a disease of unknown causation, most frequently occurring at middle life or later, usually characterized by a marked reduction in the red blood cells and hemoglobin of the peripheral blood, always associated with an absence of hydrochloric acid in the gastric secretions, and frequently complicated by degenerative changes in the nervous system." It was also necessary to add to this definition that the disease progressed, usually with spontaneous remissions, to a fatal termination within 2 or 3 years from the earliest appearance of symptoms. Before that time many types of treatment had been advocated, but with the possible exception of blood transfusions which had only a very transient beneficial effect, it could not be proven that any form of therapy prolonged the life of a given patient a single day.

Interest in the modern treatment of pernicious anemia dates from the experimental work of George H. Whipple, who in 1925[3] demonstrated that the blood of dogs, made anemic by repeated hemorrhages, would return to normal more rapidly if liver was added to the diet. It is undoubtedly true that other investigators had previously used liver in the treatment of various types of anemia, but it was the work of Whipple and later of Minot and Murphy[4] which brought this form of therapy to the attention of the general medical profession. The latter observers proved conclusively that the feeding of 240 grams of calf's liver daily would invariably induce a remission in a patient with pernicious anemia, which usually began within 3 to 6 days after the treatment was instituted. The resultant increase in red blood cells was usually at the rate of 400,000 to 500,000 cells per cu. mm. per week until the normal level of 4.5 to 5 million per cu. mm. was reached. Simultaneously with this improvement in the blood condition, there was a remarkable disappearance of all the patient's symptoms, and, unless some complication existed, there was a complete return to a state of normal health. Moreover, it has been demonstrated that this condition can be maintained apparently for an indefinite period of time, provided an adequate amount of liver is consumed. Subsequent developments in liver therapy have been the production of a concentrated soluble liver extract for oral use by Minot and Cohn[5] and similar potent products for intramuscular use by Gansslen[6] and intravenous use by Castle and Taylor.[7] These facts which have just been related demonstrate that the liver contains an unidentified substance which will cause the blood of a patient with pernicious anemia to return to normal if it is administered in appropriate amounts. Additional investigation has shown that the anemia of pernicious anemia exists primarily because there is a delay in the development of the red blood cells in the bone marrow.[8] As a result they can not be released to the peripheral blood in sufficient numbers to maintain the red blood cell count at a normal level. The failure of the red blood cells to develop normally has been termed a "maturation arrest." It can be stated definitely, therefore, that this form of anemia is due to defective blood formation.

Within recent years Castle and his associates[9] have completed and published a brilliant series of investigations dealing with the relation of the stomach to the cause of pernicious anemia, which has given more information concerning the etiology of this condition than any other contribution. For many years it was thought that a defect of the stomach had some causal relationship to pernicious anemia, but the exact nature of this association was unknown until Castle reported his recent studies. That some disorder of the stomach played a rôle in the etiology of pernicious anemia was suggested by the almost constant presence of gastric symptoms in patients with the disease, the uniform lack of hydrochloric acid in their gastric secretions and the rare but definite observation that complete removal of the stomach in human beings was followed by changes in the blood which were identical with those of pernicious anemia. In brief, it was demonstrated by Castle that when gastric juice which is obtained from normal human beings is incubated with uncooked Hamburg steak, a substance is elaborated which has the same action and is as effective as liver in controlling pernicious anemia. These experiments, which have been adequately controlled and confirmed, indicate clearly that there is some unidentified substance (the intrinsic factor of Castle) in nor-

[3] G. H. Whipple and F. S. Robscheit-Robbins, *Am. Jour. Physiology*, 72: 408, May, 1925.

[4] G. R. Minot and W. P. Murphy, *Jour. Am. Med. Assoc.*, 87: 470, Aug., 1926.

[5] E. J. Cohn, G. R. Minot, J. J. Fulton, H. F. Ulrichs, Florence C. Sargent, J. H. Weare and W. P. Murphy, *Jour. Biol. Chem.*, 74: 69, July, 1927.

[6] M. Gansslen, *Klin. Wchnschr.*, 9: 2099, 1930.

[7] W. B. Castle and F. H. L. Taylor, *Jour. Am. Med. Assoc.*, 96: 1198, 1931.

[8] I. Zadek, *Ztschr. f. Klin. Med.*, 95: 66, 1922.

[9] Wm. B. Castle, W. C. Townsend and C. W. Heath, *Am. Jour. Med. Sci.*, 180: 305, Sept., 1930.

mal gastric secretions which is closely related to the normal mechanism of red blood cell formation. Furthermore, this substance must react with some article of diet (the extrinsic factor which is likewise unidentified) to form a heat-stable material which is stored in the liver, and released as needed to regulate the rate of maturation of red blood cells in the bone marrow. These known facts compel us to conclude that the immediate cause of pernicious anemia is a lack of the intrinsic factor in the gastric secretion, but the factor which is responsible for this still remains obscure. Recent work at the Simpson Memorial Institute[10] indicates that the intrinsic substance is not entirely absent in the gastric juice of all patients with pernicious anemia, but is present in inadequate amounts. This can be demonstrated by collecting considerable quantities of gastric juice from patients with pernicious anemia and after incubating large quantities of it with Hamburg steak, inducing a remission by administering it to patients with the disease.

Pernicious anemia has been called a "macrocytic anemia" because a majority of the red blood cells of the peripheral blood are larger than normal. There are several conditions, however, which will produce a similar type of anemia. This is apparent when the normal mechanism which regulates the rate of red blood cell production is considered. The substance which controls this is the end result of a series of at least four essential steps. If any one of these is lacking, the red blood cells will not maturate properly, and a macrocytic anemia will result. The first essential to the normal development of blood is the ingestion of an adequate amount of material in the diet which has been called the "extrinsic factor." When this is lacking, as it probably is in certain tropical anemias, a macrocytic type of anemia results. Second, this variety of anemia will result when there is an absence of the intrinsic factor in the gastric secretions. As previously stated, this is known to occur in true Addisonian pernicious anemia. Third, although the extrinsic and intrinsic factors may be present and interact properly, the elaborated product may not be absorbed normally and the characteristic anemia will appear. This has been known to occur, for example, in a small group of patients who have had multiple intestinal anastomoses for some surgical reason. As a result there may be only a small portion of the intestines available to absorb this blood-regulating substance and, therefore, the amount which is made available to the body may be inadequate. Finally, a macrocytic anemia may result, following wide-spread liver damage which seriously impairs the storage capacity of this organ. While the material which regulates the maturation of the red blood cells is made in the stomach, it is stored in the liver, where it is released as required to regulate the orderly rate of red blood cell production. As a result of certain diseases, such as cirrhosis of the liver, this latter function may fail and a macrocytic anemia appear.

The work of Castle suggested to Sturgis and Isaacs that possibly gastric tissue itself should be potent in the treatment of pernicious anemia. In 1929[11] they demonstrated that desiccated, defatted hog stomach (Ventriculin) had a similar action to liver and that it was an effective form of therapy in this disease.

This group of experiments which have just been discussed have, therefore, furnished effective methods of controlling a disease which was hitherto invariably fatal, and also have provided additional information of prime importance which may eventually lead to a complete cure by the elimination of the fundamental cause of the condition.

I now wish to turn to an entirely different type of anemia but also a condition about which our knowledge has increased greatly during the past few years. I refer to the iron-deficiency anemias which have in common a depletion of the iron reserves of the body due to various causes.

While no attempt will be made to discuss the metabolism of iron in the body, the following facts should be emphasized. The entire iron content of the body of an average human adult is estimated to average about 3 grams. Eighty per cent. of this is found in the blood serum and in combination with hemoglobin, which contains 0.335 per cent. The average iron intake of an adult in the United States is commonly accepted as about 15 mg. daily and of this amount about one half is eliminated in the feces. Only the slightest trace, if any, is excreted through the kidneys. The body possesses a remarkable mechanism for the conservation of iron, as it is used over and over again. In addition, if the iron intake is reduced sufficiently, the amount eliminated in the stools is decreased and may entirely disappear.

As iron is an essential part of the hemoglobin molecule, it is perfectly clear that this essential material can not be synthesized in the absence of the metal, and an anemia will develop. Let us then consider the conditions which may result in the depletion of the iron stores in the body and a resultant anemia.

An iron deficiency of the body may result when there is an insufficient intake of this metal in the diet. An anemia of this type rarely occurs in adult males, but it is common in infants, women and in growing children. It has been clearly established that adult males will not develop an anemia when the iron intake is as small as 6 mg. daily. In women such fac-

[10] Raphael Isaacs and S. Milton Goldhamer, *Proc. of the Soc. for Exp. Biol. and Med.*, 31: 706, 1934.

[11] Cyrus C. Sturgis and Raphael Isaacs, *Jour.* Am. Med. Assoc., 93: 747, Sept., 1929.

tors as menstruation, pregnancy and lactation cause increased demands for iron and the reserves of this metal will be reduced and an anemia appear, if there is a deficiency of dietary iron. This is also true of children during a period of rapid growth, especially if there is an associated infection.

Another cause for a deficiency of iron in the body is seen in women between the ages of 20 and 40 years who apparently are unable to absorb iron in adequate amounts, despite the fact that a sufficient quantity is present in the diet. Such a condition gives rise to changes in the blood which are designated as idiopathic hypochromic anemia of women, characterized by a red blood cell count which is not strikingly changed but a hemoglobin percentage which may be 50 per cent. of normal or less. While the entire mechanism concerning the absorption of iron is not known, it has definitely been established that hydrochloric acid in the gastric contents favors the absorption of this element, whereas the absence or diminution of this acid impairs it. That the absence of it may play a rôle in the production of this type of anemia is indicated by the fact that all patients with this disease have an achlorhydria.

Probably the most common type of iron-deficiency anemia is observed when there is an excessive loss of this metal from the body, such as occurs in any condition causing chronic hemorrhage. Even a small daily loss of blood, if continued constantly for months, will gradually but severely deplete the iron reserves of the body. If the cause of the hemorrhage is controlled and the patient is partaking of a diet which is not poor in iron, there will be a gradual regeneration of red blood cells and hemoglobin until the normal is reached. Such a condition is a definite therapeutic indication for the administration of iron, as it will greatly facilitate the return of blood to normal. In the anemia which results from uncomplicated acute hemorrhage, however, iron does not have a therapeutic effect, as the normal reserve stores of this substance in the body are usually adequate to accomplish a regeneration of hemoglobin at the maximum rate.

In past years there has been a great deal of discussion concerning the therapeutic value of various forms of iron. At present it appears to be definitely established that the effectiveness of any given form of iron is directly proportionate to its metallic content. I prefer to use, therefore, reduced iron which contains 90 per cent. of the element. Ferric ammonium citrate, which contains approximately 16 per cent. of metallic iron, is also satisfactory. In order to produce satisfactory results, however, the dosage of the preparations must be much larger than is ordinarily advised. For reduced iron the maximum therapeutic dosage is 0.5 grams three times daily and for ferric ammonium citrate it is 2 gm. three times daily. When large doses of iron are administered, a very large percentage of it is excreted in the stools, and the reason why such a large dose is required to produce a therapeutic effect is not known.

The third blood disease for discussion is a condition which has been recognized only in recent years. In 1922 Warner Schultz[12] described what he regarded to be a new clinical entity, characterized by ulcerative lesions of the mucous membranes of the mouth and throat, a marked reduction or complete disappearance of the polymorphonuclear neutrophil cells of the peripheral blood, marked prostration and a rapidly fatal termination. He called this condition agranulocytosis, but later the name agranulocytic angina was given it and more recently other names such as granulopenia, granulocytopenia, malignant neutropenia and others have been applied to it. Historically at least, the terms agranulocytosis and agranulocytic angina have the preference and for that reason will be used in this article.

The mechanism of the production of this disease appears to be as follows. Some unknown agent causes the polymorphonuclear neutrophil cells of the peripheral blood to diminish in number or disappear completely either by depressing the action of the bone marrow where they are formed or by causing an increased destruction of them in the blood stream or possibly by a combination of these two factors. As a result, one of the major defense mechanisms against infection is impaired. This permits the pathogenic organisms which are always present on the mucous membrane surfaces of the body to invade the tissues, producing ulcerative lesions and, in some instances, to develop in the blood stream which almost always results in a fatal termination. While some patients may not have severe symptoms in association with this disease, it must always be regarded as a serious condition because the mortality in the untreated cases is almost 75 per cent. When it is recognized in its early stages and pentnucleotide therapy and blood transfusions are given, and these are the most promising forms of treatment, the mortality has been reduced to about 25 per cent.

For over a decade after Schultz had directed the attention of the medical profession to this disease, the cause of the reduction or disappearance of the polymorphonuclear neutrophil cells from the blood was undetermined nor was it possible to account for the characteristic tendency of these patients to suffer from relapses.

In October, 1933, Madison and Squier,[13] however

[12] W. Schultz, *Deutsche med. Wchnschr.*, 48: 1495, 1922.

[13] F. W. Madison and T. L. Squier, "Primary Granulocytopenia after Administration of Drugs Containing

reported before the Central Society of Clinical Investigation that the syndrome of agranulocytosis might be precipitated by the use of drugs composed of a combination of a barbiturate with amidopyrine. This type of medication is often prescribed by physicians and is used more and more by the non-medical public on their own initiative. These investigators observed that 14 of their patients with the disease had taken amidopyrine alone or in combination with other drugs, such as a barbiturate, immediately before the onset of the disease. This report immediately aroused my interest in this possible etiological relationship and as a result a study was made of our cases of the disease at the University of Michigan.[14] Ten patients have been observed in this hospital and it was definitely established that all of them had taken drugs or combinations of drugs containing amidopyrine in a short time before the earliest symptoms appeared. Although these observations and those contained in a number of other subsequent reports indicate clearly that patients with this disease frequently take amidopyrine before the onset of the condition, it is only indirect evidence that there is a causal relationship between this drug and agranulocytosis. More convincing data have been obtained by administering small doses of amidopyrine orally to patients who had recovered from the disease and determining the white blood cell count every half hour for four hours. In each one there was a striking decrease in the number of polymorphonuclear neutrophil cells of the peripheral blood which reached a maximum in 1½ hours and then returned to normal at the end of 4 hours. A repetition of the test in two of the patients produced exactly the same effect. These tests were controlled by observing the white blood cell count every half hour in these same patients, during which time no drug was given. Furthermore, the administration of this drug to two normal persons did not produce significant changes in the leucocyte count during a four-hour interval.

It is my opinion that amidopyrine is the drug which precipitates the disease in certain persons who are susceptible to it. As it is a widely used therapeutic agent and agranulocytosis does not have a high incidence, it must be concluded that the percentage of persons who are sensitive to it is not great.

WHAT IS A PROOF?[1]

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OUR first notion of proof may have been different from person to person, but I dare say that for none of us was it the logical process and the Q.E.D. of geometry; for all of us it was probably something quite authoritarian which first brought conviction—a reiterated statement, a punishment, an emphasis, possibly just the stamp of a foot, maybe an example, a bit of cajolerie, a reward or merely an acquired habit. This type of proof is not to be ignored, it is widely and effectively used to demonstrate the excellence of a cigaret, the indispensability of a governmental measure or the soundness of a social theory. Thus, if we were to give to the term proof a definition which had any wide validity in human affairs we should have to use some such phraseology as "a process by which A induces in B a sense of the justification for a conviction."

We may remark that A and B may be the same individual. We should note that the proof is relative to B in whom the sense of justification for the conviction is induced by the process. When a class in plane geometry first meets the Pythagorean Theorem (Euclid I, 47) with its complicated auxiliary construction lines and lengthy reasoning, the proof given will not be such to most of the youngsters because it does not carry to them a sense of justification, it is blind. Or, again, when a class in differential calculus reaches the subject of maxima and minima, the teacher with a few necromantic passes, verbal and graphical, may prove in a manner which carries both a conviction and the sense of its justification, the rule that to find maxima or minima of a function the derivate is set equal to zero; yet he knows that the theorem as stated is neither proved nor true. What may be a perfectly good proof to B may be none to A, who gives it, and a perfectly good proof to A may be none to B, who receives it.

That which has been illustrated relative to proofs of familiar propositions, holds equally of facts, as may be seen by reading "Fact: The Romance of the Mind," the latest book of Henry Osborn Taylor, our very illustrious historian of thought, wherein you can learn that what at some time has been considered indubitable fact might not be so considered now—

Benzene Chain," presented at annual meeting of Central Society for Clinical Research, Chicago, Oct. 27, 1933.

[14] Cyrus C. Sturgis and Raphael Isaacs, "Observations concerning the Etiology of Agranulocytosis" (*Trans. of the Assoc. of Amer. Physicians*, 49: 328, 1934).

[1] Read at the Pittsburgh meeting of the American Association for the Advancement of Science, before a joint session of Sections K and A with the American Mathematical Society and the Mathematical Association of America and the Econometric Society.

and who among the ancients if he should be now among us could consider as fact some of the things we here cherish as such?

I have alluded to mathematical proofs. We learned the paraphernalia thereof in geometry, consisting of definitions, postulates or axioms and demonstrations. The whole was a logical construct based on conceptions and without any other kind of reality. However much you might stumble mentally at the Pons Asinorum, you could not stub your toe on it! So far as many of us believe, we sense only material things, things containing mass or energy. A point being position without extension could therefore not be directly sensed. Indeed, if we adopt the principle of indeterminacy, as some of us do, how could we specify the position of a point without endowing it with an infinite momentum? And in view of our notions on relativity should we not have to speak not at all about points in space but of events and of space-time?

You thus all see what a terribly unreal fiction this plane geometry is. Fortunately, this does not bother the high-school teacher or the modern physicist could never have got his necessary mathematical start.

In the above extravaganza, or excursion into reality, I am merely trying to emphasize the idealization which is necessary to get up a system of plane geometry and the purely conceptual nature of geometry. Our definitions, postulates and theorems apply to things which do not exist materially. Now when the trusting schoolboy, who does not appreciate what is being imposed on him, having learned that the area of a triangle is half its base times its altitude, undertakes to apply this theorem to find the area of a somewhat triangular object, as may be needed for some practical purpose, he quite unconsciously makes more postulates or assumptions, to wit, that the given object is sufficiently triangular so that he may apply his theoretical formula to the solution of a practical problem. In more complicated fields of theory and practice such additional assumptions may be wide of the mark. In other words, applied mathematics must, in the nature of things, transcend pure mathematics.[2]

If we turn now to the social sciences do we find definitions, postulates and theorems? Certainly we find a lot of statements, but which are the definitions, which the postulates and which the theorems? And which of the statements have to do merely with the conceptual scheme we are trying to set up, and which with those supplementary transitional propositions whereby we assert that in the particular practical situation which confronts us the elements of the conceptual scheme correspond adequately to the realities of the situation to enable us safely to assert that the application of the conceptual scheme to the actual situation is justified?

To take a special instance: Is there any theory of money which does not appear to fly in the face of enough facts, which does not patently neglect enough possibly important variables of our economic (and psychological) system, which does not so much lean on secular trends as to render doubtful the feasibility of accomplishing by monetary manipulation that degree of economic control which some claim? Even if you can follow, as I can not, the logic of J. M. Keynes's "Theory of Money,"[3] can you follow with conviction his transition to a system of regulation by manipulation of the bank rates or by large-scale governmental spending, or would you be tempted to give the citation: "J. M. Keynes, dazzling terpsichorean, enricher of his College by war time speculation with her funds, now impoverishing a great republic by her adoption of his even more speculative theories." The social sciences must become less enamored of the dazzle of the intellectual dance hall and more satisfied with the daily grind of work. Maybe the long-continued studies of our vice-president, Mr. Snyder, will help both with their findings and by their example.[4]

I would not imply that there is no ascertained and widely agreed-to body of knowledge in the social sciences; there is, at least in a general way, a larger amount of agreement and of demonstration than is commonly believed by those unfamiliar with the social sciences, but efforts at reducing the body of the subject to neater form are very necessary in order that all may have a clearer picture of that on which they agree and a sharper realization of the crucial elements in the disagreements which must ever be in evidence so long as the subject is alive and advancing.[5] It is, I understand, the object of the Econometric Society to proceed along those lines. The society will, however, be handicapped in its efforts unless it can draw a line between pure science and applied science. The task will require patience; for a long time we shall

[2] "What is sometimes called 'applied' science, may then be more truly science than what is conventionally called pure science. For it is directly concerned with not just instrumentalities, but instrumentalities at work in effecting modifications of existence in behalf of conclusions that are reflectedly purposed." From John Dewey, "Experience and Nature," p. 161. (Not from the "People's Lobby.")

[3] See, among other references, John Williams, *Quarterly Journal of Economics*, 45: 547–587, 1931; A. H. Hansen and H. Tout, *Econometrica*, 1: 119–147, 1933; K. Rübner-Petersen, *American Economic Review*, 24: 595–602, 1934.

[4] Carl Snyder, *Quarterly Journal of Economics*, 49: 173–205, 1935.

[5] That there are disagreements at the research frontier is well illustrated by R. A. Millikan, SCIENCE, 81: 1935.

have difficulty in limiting ourselves to proofs which have mathematical precision. Moreover, there need be little correlation between the amount of formal mathematics used by the investigator and the substantial validity of the proof offered.

It is a homely saying that the proof of the pudding is in the eating thereof. For most practical purposes this may be a sounder proof than any based on the perusal of the recipe or on a chemical analysis of the constituents. Many a recipe which ought to have made a fine pudding has resulted in one quite inedible.

In many proofs we introduce the notions of cause and effect. We do not often so speak in the composition of puddings, and the validity of a notion may be questioned. In geometry we do not say that the base and the altitude of a triangle cause the area to be what it is. We think merely of the three quantities, base, altitude, area, as connected by a certain relation. In mechanics we no longer think that the force causes the motion; we have only concomitancy of variables. In complex systems which depend on a multitude of variables connected by a variety of relations, often unknown, it is clear that the usual situation must be that any imposed change in one of the variables may be distributed widely through the system; if the system is in quasi-equilibrium, if it is a going concern, it will probably exhibit the characteristic of homeostasis,[6] in the terminology of Dr. Cannon. The analysis into cause and effect is more necessary when one comes to speak of control, for control consists in obtaining the desired effects (and avoiding undesired ones) through specific measures. The element of the will enters, the individual or social will, and, with it, causation in a sense somewhat different from that in which it is attributed to non-willing nature. It does not do to overlook such generalities in speaking of proofs in a practical world.

My fundamental contention, then, is that proofs, truth and facts must be relative to our culture and conditioned by it; that for different purposes they must not only be different but may even be differently conceived; that science can not be all things to all men but must consist of some very special things to limited groups of specialists who deal with various questions of pure and applied science. For our development we have to depend on the professional ethics and the professional discrimination of those small groups; they must not fool themselves or attempt to fool one another within a group as to what is a proof or as to what are the facts; it may be impossible for them to explain themselves truthfully to non-specialists without departing widely from the strict canons of proof which they adopt among themselves.

SCIENTIFIC EVENTS

THE NEW CHAIR OF ASTRONOMY AT THE ROYAL INSTITUTION

IN connection with the establishment of the professorship of astronomy at the Royal Institution, to which Sir James Jeans has been nominated, the London *Times* writes as follows:

The year 1863 was the last occasion when a new chair was created. This was for Dr. (afterwards Sir Edward) Frankland, who was elected to a separate professorship of chemistry, while Faraday was still the Fullerian professor of chemistry. Frankland's professorship lapsed after Faraday's death. The other "elected" professorship in the institution at the time, that of natural philosophy, had been established ten years earlier, and was not so short-lived. It was created for Tyndall when he went to the institution in 1853, and since his retirement in 1887 has continued by election and reelection down to the present day.

By their resolution to establish a new professorship, the members of the Royal Institution have exercised a privilege they have possessed since the foundation of the institution. A proposal for a professorship in astronomy was made and agreed to in 1811, but no appointment followed and the proposal was dropped. But astronomy is by no means a new subject to the audiences at the Royal Institution. It has appeared at intervals in the lecture lists and has been of particular interest to the sons and daughters of members, for the first of the famous Christmas courses "addressed to a juvenile auditory" was given by Wallis in 1826 on an astronomical subject; and in later years Sir Robert Ball, Sir David Gill and Professor H. H. Turner became popular Christmas lecturers on astronomy.

Sir James Jeans is already known to the children of the present members of the institution, for he gave the Christmas lectures of 1933 on "Through Space and Time." It is by these lectures that he satisfies the requirement of the by-laws that a new professor must have delivered a course of lectures to the institution within two years previous to his election.

Since Tyndall, three physicists of great distinction have held the professorship of natural philosophy at the institution and have also been, in turn, the Cavendish professor of physics at Cambridge. The late Lord Rayleigh soon after his retirement from Cambridge accepted an invitation to the chair of the Royal Institution

[6] The effort to view the economic system of a country as a whole with the understanding that a multiplicity of well-balanced measures is necessary to get and keep the balance of the system is well illustrated by Douglas Copland's "Australia in the World Crisis." Dr. W. B. Cannon's book is entitled "The Wisdom of the Body."

and held it until 1905, when he was succeeded by Sir Joseph J. Thomson. The present professor, Lord Rutherford, took up the duties in 1921. The rules prescribed at the beginning of the institution for the election of professors are still followed, and thus it is that Lord Rutherford as an "elected" professor must seek the suffrages of the members every year, while Dewar's successor in the endowed Fullerian professorship of chemistry, the present resident professor, Sir William Bragg, does not do so.

THE STRATOSPHERE BALLOON OF THE NATIONAL GEOGRAPHIC SOCIETY AND THE U. S. ARMY CORPS

THE completion of the gondola for the flight to the stratosphere planned for June under the auspices of the National Geographic Society and the U. S. Army Air Corps has been announced.

The gondola, made in Midland, Michigan, of a magnesium alloy lighter than aluminum, has been shipped to Dayton, Ohio, where, at Wright Field, its equipment will be installed under the supervision of Captain Albert W. Stevens and Captain Orvil A. Anderson, the commander and pilot for the flight. The gondola will then be shipped to Rapid City, South Dakota, from the neighborhood of which the ascent into the upper atmosphere will be made.

The hollow metal ball is nine feet in diameter, the largest gondola yet designed for stratosphere exploration. Last year's gondola was eight feet, four inches in diameter. A level floor extends across the sphere a foot and a half above its lowest point; and on this the two balloonists will have ample room in which to move about and take care of their air-conditioned, floating laboratory.

The flight this year will make use of a balloon considerably larger than any heretofore built. The giant bag now under construction in Akron, Ohio, will have a capacity of 3,700,000 cubic feet of gas.

Utilizing the experience gained last year, when their 3,000,000 cubic-foot balloon developed a tear and crashed in southern Nebraska, the sponsors of the flight have incorporated many improvements. The most important difference will be the use of helium gas instead of hydrogen. Helium can neither burn nor explode. It is more expensive than hydrogen, however, and has never before been used in stratosphere exploration.

CONFERENCE ON SPECTROSCOPY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A THIRD special program on spectroscopy and its applications is to be held at the Massachusetts Institute of Technology this summer, culminating in a research conference to be held during the week of July 15 to 20. This conference, which is to be held in the George Eastman Research Laboratories, will comprise lectures and discussions on photographic photometry, absorption spectrophotometry, spectroscopic analysis of materials, biological and chemical effects of spectral radiation, spectroscopy of the extreme ultraviolet, and astronomical applications of spectroscopy. The meetings of the first day will be largely devoted to consideration of general spectroscopic problems of the metallurgist, chemist and biologist; on Tuesday and Wednesday the chief emphasis will be on specific applications of spectroscopy to biology and medicine. During the latter part of the week applications of spectroscopy to astronomy will be emphasized, a portion of the program being held in collaboration with the Harvard Observatory Summer School.

The research conference coincides with the conclusion of the summer school courses in practical spectroscopy and the meetings are open to all those interested. An invitation is being extended to all properly qualified investigators, to make use of the facilities of the laboratory of spectroscopy in connection with their researches during such portions of the summer months as they may desire. A bulletin giving further information regarding the entire summer program on spectroscopy can be obtained by addressing Professor G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge.

FELLOWSHIPS OF THE CHARLES A. COFFIN FOUNDATION

THE fellowships of the Charles A. Coffin Foundation of the General Electric Company have been awarded to eight college students from widely separated sections of the country to enable them to pursue studies and carry on research which, without such financial assistance, they would be unable to undertake in educational institutions of their choice. The fellowships are awarded annually to encourage and assist in the pursuit of research activities in the fields of electricity, physics and physical chemistry.

Fellowships have been granted by the Charles A. Coffin Foundation annually since 1922, when the foundation was created by the board of directors of the General Electric Company for the composite purpose of assisting deserving college graduates in postgraduate work, recognizing the achievements of electric power companies, and electric railway companies, and rewarding employees of the General Electric Company who each year advance the efficiency of the company or contribute by meritorious work to progress in the electrical arts. Since 1923, the foundation has made available a total of $65,000 for fellowships. This year there were seventy-three students who submitted applications to the committee of award.

It is reported by the General Electric Company that sixty per cent. of those men who five years or more

ago received Charles A. Coffin fellowships already have achieved a reputation for distinct contributions to science. Of the 45 men to whom these fellowships were awarded during the period 1923–1929, the names of 27 men are listed in the latest edition of "American Men of Science." At least ten of the group have attained national reputations, and some of them are already known internationally. At least three quarters of the group of seventy-two who received awards during the period 1923 to 1933 are now associated with universities or industrial organizations, carrying on research investigations.

Charles A. Coffin was one of the founders of the company, serving as its head for thirty years as its first president and as chairman of its board of directors. He died in 1926.

The committee on awards consisted of Dr. Bergen Davis, of the National Academy of Sciences, C. C. Williams, of the Society for Promotion of Engineering Education, and J. Allen Johnson, of the American Institute of Electrical Engineers. The committee was assisted by Dr. William D. Coolidge and Dr. Saul Dushman, both of the General Electric Research Laboratory.

SCIENTIFIC NOTES AND NEWS

Dr. Frank Dawson Adams, from 1894 to 1931 Logan professor of geology at McGill University, now emeritus professor and vice-principal, has been elected an honorary fellow of the Geological Society of Edinburgh.

The medal and certificate of award of the St. Louis Medical Society has been presented to Dr. Edward A. Doisy, professor of biochemistry at the St. Louis University School of Medicine, in recognition of his work on the estrogenic hormones and for the isolation and preparation of theelin. Dr. Philip Shaffer, professor of biological chemistry at the Washington University School of Medicine, made the presentation address.

Samuel Louis Hilton, retail pharmacist of Washington, D. C., has been awarded the Remington Honor Medal for 1935 in recognition of his many years of service to the profession which culminated this year with the completion of the American Institute of Pharmacy, national headquarters of the profession in Washington. Mr. Hilton has served as president of the American Pharmaceutical Association and chairman of the council and has been a member of the revision committee of the United States Pharmacopoeia and at present is treasurer of the pharmacopoeial convention.

Raymond E. Davis, professor of civil engineering at the University of California, was recently awarded for the second time in four years the Wason Medal given by the American Concrete Institute. This award is made annually for the best paper on concrete presented to the institute during the year.

Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, was guest of honor at the annual meeting on April 9 of the New York Chapter of the Alumni Association of the Carnegie Institute of Technology. He spoke on the work of the Board of Trustess of the institute, of which he is a member.

Dr. Hugh S. Cumming, surgeon-general of the United States Public Health Service, is among the alumni elected to membership in the Chapter of Sigma Xi of the University of Virginia. Formal initiation ceremonies for the new members will be held on April 24, when Dr. Ernest O. Lawrence, professor of physics and director of the radiation laboratory at the University of California, will give the annual Sigma Xi address.

The William Mackenzie Medal for 1935 "for original contributions to ophthalmology of outstanding merit," has been awarded by the custodians, the Glasgow Eye Infirmary, to Dr. Ida C. Mann. The medal will be presented on June 7, when Dr. Mann will describe her work.

Nature reports that at the meeting of the Australian National Research Council at Melbourne, the first award of the Lyle Medal was made, the recipient being Professor J. R. Wilton, Elder professor of mathematics in the University of Adelaide. This medal is to be awarded, at intervals of two years, to workers in Australia for such researches in mathematics or physics as may appear to the council most deserving of such honor, the period covered being the five years preceding each award.

At a recent meeting the Cleveland Academy of Medicine has awarded the title of honorary secretary for life to Dr. Jacob Edward Tuckerman in recognition of thirty-three years of continuous service to the academy in various capacities. Dr. Howard Lester Taylor, president, presented to Dr. Tuckerman an illuminated parchment on which was inscribed the action of the society, and Dr. George E. Follansbee paid tribute to his long service.

The University of Cincinnati Section of Sigma Xi has elected the following officers: *President,* Dr. Charles N. Moore, professor of mathematics; *vice-president,* Dr. John H. Hoskins, associate professor of botany; *secretary-treasurer,* Dr. Saul B. Arenson, associate professor of chemistry.

DR. HENRI HARTMANN, professor of clinical surgery at the University of Paris, has been elected vice-president of the Paris Academy of Medicine.

DR. E. B. FORBES, director of the Institute of Animal Nutrition of the Pennsylvania State College, is visiting the agricultural experiment stations in Illinois, Minnesota, Missouri, Arizona and California. He spoke before a joint meeting of the Missouri chapters of the honor society of agriculture, Gamma Sigma Delta, and the Society of the Sigma Xi on March 19 on "Conditions Affecting the Utilization of Feeding Stuffs."

DR. URAL S. ASHWORTH, instructor in agricultural chemistry at the University of Missouri, has been awarded the Alexander Brown Coxe Memorial Fellowship in biological science at Yale University. Dr. Ashworth will continue his work on the composition of the body as it affects endogenous metabolism.

THE committee on scientific research of the American Medical Association has made a grant to Dr. Roy H. Turner, assistant professor of experimental medicine at Tulane University, to aid in studies of physiology in peripheral blood vessels in man. The David Trautman Schwartz Research Fund and the Josiah Macy, Jr., Foundation are also contributing towards the support of the researches of Dr. Turner and his associates.

AT the forthcoming meeting of the Pacific Division of the American Association for the Advancement of Science, Dr. K. F. Meyer, director of the Hooper Foundation of the University of California, will make an address on June 27 on "Plague—Past and Present."

THE James Arthur Lecture on the evolution of the human brain will be delivered on April 25 at the American Museum of Natural History, New York City, by Professor C. U. Ariëns Kappers, of the University of Amsterdam.

DR. GUIDO BECK, recently appointed professor of theoretical physics and director of the Institute of Theoretical Physics at the University of Odessa, U. S. S. R., lectured at the University of Oklahoma on April 5 and 6. His subjects were "The Theory of the Positive Electron" and "The Theoretical Treatment of the Radioactive Beta-decay." Dr. Beck is at present visiting professor at the University of Kansas.

DR. GEORGE E. UHLENBECK, professor of theoretical physics at the University of Michigan, recently gave three graduate lectures at the State University of Iowa. These were: "Statistical Energy Distributions for a Small Number of Particles, with Special Applications to Disintegration Problems"; "The Theory of β-ray Radioactivity" and "The Stability and the Interaction of Proton and Neutron."

PROFESSOR A. E. DOUGLASS, of the University of Arizona, gave a lecture on March 30 at the University of Kansas City before a joint meeting of the Kansas City Section of the American Meteorological Society and the Sigma Xi Club of Kansas City. His subject was "Annual Rings in Trees and Long Range Weather Forecasting."

PROFESSOR NELS A. BENGTSON, chairman of the department of geography of the University of Nebraska and president of the Nebraska Academy of Sciences, will lecture during the summer session of Columbia University. He will give courses in economic geography and will conduct a special seminar in geography.

THE tenth International Congress of the History of Medicine will be held in Madrid from September 23 to 29, when the subjects for discussion will be: Arabian medicine in Spain; medicine in America during its discovery and colonization, and medical folklore in various civilized countries.

Industrial and Engineering Chemistry reports that the fourth International Congress of Agricultural Industries, which is to be held in Brussels from July 15 to 27 in connection with the Universal Exposition of 1935, is being organized by the International Commission of Agricultural Industries. The third congress was held last year, at Paris, and although intervals of three years between the congresses will ordinarily be observed, it was decided to hold the fourth congress in 1935, in order to set up a more effective organization of the congresses and take advantage of the Brussels exposition. The congress will be organized in four divisions: general scientific studies, agronomic studies, industrial studies and economic studies. There will be some twenty-six sections comprised in these four general divisions. In order to assure discussions of timely interest, special reporters upon ten such topics will be appointed, and the reports prepared by them printed and distributed in advance in order to assure fruitful discussion of these questions of priority. Applications for membership and for further information should be addressed to the International Commission of Agricultural Industries, 156 Boulevard Magenta, Paris (X^e), France.

ACCORDING to *Nature*, at the next General Assembly of the International Astronomical Union, to be held at Paris from July 10 to 17, the French National Committee of Astronomy is arranging an exhibition of astronomical documents and apparatus, to exhibit the principles and the details of application of the methods of observation employed. The examination

of actual instruments shows better than any description how they are applied, while original negatives or positives on glass will enable the quality of the results obtained to be judged. The exhibition will enable astronomers to examine the documents serving as the foundation of the astronomical discoveries of the present century. It is particularly hoped that auxiliary apparatus and accessory contrivances of all kinds will be exhibited by observatories and instrument makers: such instruments are micrometers, chronographs, photometers, spectrographs, driving motors, observing sheds and seats, abacuses, numerical tables and calculating machines. Inquiries can be addressed to M. le Comte de la Baume Pluvinel or to Professor C. Fabry at the Paris Observatory.

A CORRESPONDENT writes: "The annual banquet and dance of the Botanical Society of Washington, D. C., was held on April 2 in the ball room of the Kennedy-Warren with an attendance of 187. After the dinner, Dr. Wm. H. Weston, Jr., professor of cryptogamic botany at Harvard University, gave an illustrated lecture on 'Sex in the Lower Fungi.' A most amusing, well-executed farce was presented by members of the society, the outstanding feature of which was the original poetry read by Dr. L. H. Flint."

GUEST speakers at the annual convocation on May 3 and 4 of the Nebraska Academy of Sciences, which will be held at the University of Nebraska, will be Dr. Victor Levine, of Creighton University, and Dr. J. B. Kincer, chief of the division of climate and crop weather of the U. S. Weather Bureau. The subject of Dr. Kincer's address will be "Man and His Climate with Special Reference to the Great Plains."

THE Virginia Academy of Science will hold its thirteenth annual meeting at the University of Richmond, Virginia, on May 3 and 4. One hundred thirty-five papers will be read and discussed in the sections of astronomy, mathematics and physics, biology, chemistry, geology and the medical sciences. Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution in charge of the U. S. National Museum, Washington, will be the principal speaker at the general session of the academy. His subject will be "Explorations in Hawaii."

ACCORDING to *The Museum News* the Washington meeting of the American Association of Museums will be held for three days beginning on May 23. There will be general sessions in the mornings with a more than usually varied list of speakers, and sectional conferences on one afternoon and two evenings. The meeting will end on Saturday with a trip of four hours on a chartered Potomac steamer. A similar feature years ago gave opportunity for getting acquainted and for informal discussions. There will be one free afternoon to visit the museums of Washington. The Southern Museums Conference will be held on May 22, the day before the opening meeting of the association. The headquarters hotel, The Willard, offers rooms at rates from $2.00 to $6.00 a person. Reservation cards, with full details, will be mailed to members.

THE department of geology of the University of Wisconsin will conduct its biennial field trip in the pre-Cambrian area of the Lake Superior region from May 17 to 26. The trip will be under the direction of Professors C. K. Leith and Andrew Leith.

THE seventh Smithsonian anthropological and archeological expedition to Alaska, under Dr. Aleš Hrdlička, will leave Seattle on May 18. The excavations, as during the two preceding seasons, will be on the Kodiak Island. As on his previous trips, Dr. Hrdlička will be accompanied by a party of volunteer college students who with him will carry on the excavations. These students receive, aside from the field training, a course of tri-weekly lectures on the human skull and skeleton, on general anthropology and on the principles of American archeology. No charge is made for this instruction, but the students pay their own expenses. Due to the limited accommodations the number of students for the coming season must be limited to eight. There are still two vacancies. Applications should be made to Dr. A. Hrdlička, U. S. National Museum, Washington, D. C.

THE council of New York University has approved the change in name of the medical school of the university from New York University and Bellevue Hospital Medical College to New York University College of Medicine.

APPLICATIONS for the positions of associate engineer and assistant engineer in soils mechanics must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than May 6. The entrance salary for the associate grade is $3,200 a year, and for the assistant grade, $2,600 a year. These salaries are subject to a deduction of 3½ per cent. toward a retirement annuity. The duties are to make or supervise the making of soil tests to determine coefficient of cohesion, angle of internal friction, time and amount of consolidation, coefficient of permeability, etc.; to devise and supervise the design of apparatus and equipment necessary for the testing and procurement of representative samples of soils and subsoils, and to analyze data and prepare reports on the condition and nature of soils and sub-soils as engineering and foundation material. Specified education and experience are required.

THE *Journal* of the American Medical Association reports that by the will of the late Walter G. Ladd,

the following bequests will become effective after the death of his widow: Somerset Hospital, Somerville, N. J., $100,000; Elizabeth General Hospital and Dispensary, Elizabeth, N. J., $25,000. The remainder of the estate, about $10,000,000, will be divided into three trust funds: one to maintain the family estate in New Jersey as a convalescent home for "deserving gentlewomen," one to aid such persons elsewhere and the third to be used for hospitals, medical schools, universities, colleges and similar institutions "not existing for pecuniary profit." At the end of fifty years, the trusts are to be terminated and the principal will be divided among several institutions, including the New York Post-Graduate Medical School and Hospital and the Johns Hopkins Hospital.

THE University of Cambridge, England, has received a gift from Dr. G. P. Bidder, of Trinity College, to be used for a ten-year period for the benefit of occupants of the Cambridge table at the zoological station in Naples. It has also received a grant of £5,500 from the Goldsmiths' Company for an investigation of the alloys of silver to be carried out under the direction of Dr. R. S. Hutton, professor of metallurgy, Clare College, Cambridge.

Nature states that two new research laboratories are to be built for the Council for Scientific and Industrial Research of Australia, using money voted for relief of unemployment. One, at a cost of £6,000, will replace an existing small building at the Council's viticultural research station near Mildura on the River Murray, where investigations into problems of the dried grapefruits industry have been in progress for many years. The other will house the Forest Products Division, which hitherto has carried on in temporary quarters in Melbourne. The new laboratory, to cost £25,000, will be in the midst of the city's timber yards, and this should mean decided increase in the practical effectiveness of the division's work.

ALLOTMENT of $7,500 of Hawaiian sugar processing tax funds for the purpose of initiating a soil survey in the Territory of Hawaii has been made in an order which has been signed by Secretary of Agriculture Wallace and approved by President Roosevelt. The purpose of the survey is to secure comprehensive data on the adaptability of soils in various areas in the territory, particularly to serve as a guide in the use of land for crop diversification. The survey has been recommended by the Hawaiian Agricultural Advisory Committee appointed by the Secretary of Agriculture. The Bureau of Chemistry and Soils of the Department of Agriculture, which will collaborate with the University of Hawaii, has been placed in charge of the technical work of the proposed survey.

DISCUSSION

THE SIGNIFICANCE OF FOOD HABITS RESEARCH IN WILD LIFE MANAGEMENT[1]

THE term "wild life management" has taken on a meaning somewhat distinct from the older "conservation," in that it implies a less passive technique. It lays more emphasis upon the improvement and maintenance in an improved condition of environment for wild species and not so much upon the provision of sanctuaries and legal protection. This change of emphasis is entirely consistent with modern ecological thought. Meager as our knowledge may be, we are no longer so prone to assume that species may thrive in habitats unsuited to them, even if permanently protected against persecution by man.

Wild life management, as the term is used here, is not artificial propagation; it is the encouragement of wild creatures under conditions as nearly natural as possible. It does not inevitably follow that management of a species is synonymous with encouragement, though it commonly does. Broadly, management is human manipulation of wild populations and may be motivated by economic, esthetic or scientific objectives.

The earlier efforts at management were, as might be expected, characterized by a great deal of blind groping.[2] This handicap has not been wholly removed from modern management either, for two chief reasons. In the first place, wild life management is beset by a formidable array of cherished popular prejudices which yield to contrary evidence with extreme slowness, if at all. Secondly, there is still a real deficiency in basic information on ecological questions.

While it may doubtless be said that many of the latter questions are unanswerable, it may be said with equal truth that many are so elementary and pertinent in relation to wild life management that their continued neglect does not flatter our sense of perspective. Intermediate between questions of these two extreme types, complex and simple, are a host of others, significant alike to pure and to applied science, at least some of which should prove amenable to investigation.

One of the most fundamental phases of ecological research pertaining to wild life management is the study of the food habits of animals. This should not

[1] Journal Paper No. J219 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project No. 329.

[2] Aldo Leopold, "Game Management," pp. 3–21. *Scribner's*, 1933.

be confined solely to the identification of what animals eat, however deficient our knowledge may still be even in that respect. Our knowledge of the general food habits of lower vertebrates is inadequate for immediate needs, and this is also true for many birds and mammals of obvious economic importance.

General food habits studies constitute a necessary groundwork for the more specialized research that may profitably follow. The most useful single technique for extensive investigation at present seems to be that of stomach examination, supplemented by, or combined with, whatever field observations and fecal or pellet analyses may be advantageous. Frequently emphasis may be placed upon one of the minor techniques in the attack of specific problems, such as pellet analyses for the study of some owls.[3]

Great as may be our immediate need for vastly more general food habits data, probably greater needs may be served by diversification and intensification of food habits investigations. The realization of these potentialities should be of extreme significance to the progress of ecological science as a whole, as well as to that particular branch known as wild life management.

In planning management of any species, not only do we need to know what it eats, but also what foods it has access to, especially under changing conditions. We need to know more about what determines availability of foods; more about the influence of adaptations, experience, preferences and physiological demands on feeding tendencies of animals; and about what foods are essential to the existence of a species and what are incidental or conceivably detrimental.

The sound administration of a waterfowl or shorebird or any other sort of wild life refuge is dependent on adequate information on these points. The refuge may provide proper food for the desired species, but it may not. Perhaps something may reasonably be done to correct food deficiencies, perhaps not. At any rate, the wild life administrator is not likely to find it to his disadvantage to know something about what he is trying to do; and on many subjects he can know only through the research of others.

Understanding of the basic problem of predation, of which we have very great need, involves intensive research on food habits and on factors governing food habits of predatory species. Stimulation of local research would be particularly in keeping with the growing trend in conservation thought toward the conclusion that enlightened and truly effective predator control should attempt far more than at present to make game, poultry, etc., difficult for predators to get rather than to attempt great reduction in numbers by drastic campaigning against the predatory species themselves.

Here, too, we need to know much more than what a species may eat. What are the adaptations of a predatory species for capturing and handling prey and what are the adaptations of the prey for defense or escape? What factors importantly affect the relative security or vulnerability of prey? What difference does predation actually make to the prey species, anyway? The fact that a species suffers a certain amount of predation—even conspicuous or heavy predation—does not necessarily mean that it is controlled or that its population levels are appreciably affected thereby.[4]

Work in this general direction is gradually gaining headway through the activities of a number of colleges and universities, some of the more advanced state fish and game departments and other private or public agencies. Agricultural colleges have recently displayed increasing recognition of the opportunities for constructive programs centering about local researches on specific wild life problems and in several instances have been making adjustments as rapidly as their budgets have permitted.

The Division of Food Habits Research of the U. S. Biological Survey has participated creditably in practically every substantial movement of consequence to wild life management in the country, despite its small staff and limited funds. It seems more than a little ironical that this division with its highly trained personnel, its unmatched reference collections and its strategic possibilities as an ecological clearing house should be the perennial target of crippling economies, with occasionally its very existence threatened.

In short, from the standpoint of one interested in wild life management and foreseeing the great development that will surely occur, it is apparent that the necessary supporting researches into the food habits of organisms are barely entering the tremendous field of significant endeavor that awaits. Continued progress may call for refinement and elaboration of techniques and for a greater breadth of vision on the part of the workers, but not less for greater understanding and appreciation on the part of the public. The intrinsic value and promise of the science alike are boundless, and support for it should be forthcoming in generous measure.

PAUL L. ERRINGTON

IOWA STATE COLLEGE

[3] Paul L. Errington, *The Condor*, 34: 75–86, 1932.

[4] Paul L. Errington, *Ecology*, 15: 2, 110–127, 1934.

MASTODON AND OTHER REMAINS AT AURORA, ILLINOIS

FINDING of mastodon parts and other material during recent months will contribute items of interest

regarding the life of this vicinity in early post-glacial times. The finds were made by CWA workers while digging for an artificial lake in a swamp in Phillip's Park, which is located in the southeast part of Aurora, Illinois.

The mastodon parts consist of three skulls, one of which includes the lower jaw, three tusks, a femur, an ulna, a scapula, a number of ribs, several vertebra and a number of foot bones. Most of the material is in excellent preservation. E. S. Riggs, paleontologist at the Field Museum of Natural History in Chicago, has identified the species as being *Mastodon americanus*. There were also found in the same formation as the mastodon material three pairs of bird humeri and a portion of breast, all of the same species of bird. Identification has not yet been made of the bird specimens, but they are being examined by Professor L. A. Adams, of the University of Illinois. The size suggests a bird possibly four feet in height.

The deposit in which the mastodon and bird material was found is a bed of gray marl enclosed on three sides by hills of glacial till, and situated a mile and a half east of the Fox River. Professor William E. Powers, of Northwestern University, has examined the geological features of the locality, and believes that the marl represents a post-glacial lake which probably once connected with the river. A series of borings made in a north and south line across the marl bed revealed a maximum thickness of thirty feet. Overlying the marl was a layer of peat varying in thickness from two to five feet and over this about two feet of black muck which comprised the bottom of the modern swamp. The mastodon and bird skeletal parts were found in the upper three feet of marl, with the exception of the scapula which was in clay at the margin of the marl bed. This was the first specimen found, and obscurity of reports as to exact locality do not justify definite conclusions as to whether it differs in age from the rest of the specimens.

A hemlock cone found in the cavity of one of the mastodon tusks has been identified by Dr. W. T. McLaughlin, of Northwestern University, as being of the species, *Tusga canadensis*. Several other cones found in the marl of the same vicinity, he considers to be of the same species. There were also found two cones which he considers to be apparently black spruce, *Picea mariana*.

Professor F. C. Baker, of the University of Illinois, has identified twenty-one species of shells in a sample of the marl sent to him by Professor Powers. Baker reports[1] that "it is, as far as climate is concerned, a cold-temperate fauna." He also states that it is "quite like the marl fauna found a few years ago in the bottom of Green Lake, Wisconsin, which is certainly middle Wisconsin in age, not later." He considers the cones of hemlock and spruce as further indication of a cold-temperate climate.

Another find of interest was a right femur of the giant beaver, *Castoroides ohioensis*, the specimen being identified by Professor Adams. It was reported by workmen to have been found in the peat layer, but there is reason for believing that this may be an error and that the specimen was more likely in the marl.

In the peat layer quite a collection of mammal skeletal parts has been found and most of it examined by Professor Adams. Most frequently represented is the Virginia deer. A skull he has identified as that of a female elk. The most recent find in the peat layer is a skull apparently of a muskrat. This has not yet been studied in detail.

With the completion of the lake-digging project the finding of specimens has now come to an end. Much remains to be done in studying the specimens and the data which has been recorded, and plans are under way by which it is hoped that more detailed reports will later appear in the scientific literature. The city of Aurora is keeping the specimens on display in a museum at Phillip's Park.

CLARENCE R. SMITH

AURORA COLLEGE

[1] Personal communication to William E. Powers.

LONGEVITY IN THE BOX TURTLE

IN the summer of 1896 a box turtle (*Terrapene carolina*) was captured on my father's farm in Ohio. This specimen had a carapace 6½ inches in length. There was a small round hole through edge of the shell about midway of the arc between the forefoot and the neck. On the back, slightly off the midline to the left, was an irregular scar approximately an inch in diameter, apparently produced by burning, as the contour of shell was not distorted, as would be the case if due to a blow or crushing. Partly merged with this were two letters, one an R, the other unidentifiable. These letters had evidently been carved, but at that time the markings had the appearance of stippling or pitting, the instrument cuts being almost completely obliterated.

There were two other sets of initials identifiable as those of two men of the neighborhood. Later it was recalled by others that these two men had been seen to carve their initials in the shell of a turtle 16 or 17 years before. Testimony differed on the exact time. One of these men had been dead nearly 16 years.

Comparison of these letters with the older ones would lead one to conclude that the latter must have been placed there many years earlier. The outline of

the R was not distorted, as might have been the case had the animal grown after the carving was done.

By means of the hole mentioned, the animal was tied up in the yard and kept until the approach of cold weather, when it was released. It was found again the following year about 300 feet from the house and has been recaptured at frequent intervals since, the last time in the late summer of 1933. Neither its size nor appearance had altered in the intervening 37 years, except that there is some indication of pitting in the second set of letters.

A total of 53 years of this turtle's life may be accounted for quite accurately. The animal was certainly well grown when the first letters were carved. There is no doubt that they *were* carved originally, because when captured in 1896 there were instrument cuts still visible. The question arises as to whether the pitting is an evidence of a healing process and therefore related to the age of the cuts.

The later set of carvings showed no evidence of pitting in 1896, but when observed by the author in 1932 had begun to pit—about 50 years after they were made. This fact suggests that the pitting bears a general relation to the age of the wound. If so, the condition of the earlier carvings would indicate that they were much more than 50 years old in 1896, unless the process takes place more rapidly in the shell of a young animal.

In none of the literature cited below was there found any reference to pitting in similar carvings, although some of them were more than 50 years old. Whether they were not present or were not noted can not be determined.

If one allows 5 years for growth to adult size, and 20 years for the repair processes in a young turtle, this brings the total estimated age to 78 years in 1933. Unless the significance of the markings is greatly misinterpreted, this would seem to be a conservative estimate of this turtle's age.

An incomplete survey of the literature reveals the following records which seem to be quite authentic: Deck,[1] 88 and 87 years; Medsger,[2] 35 years; Koch,[3] 32 and 41 years; Nichols,[4] 78 years; Flower,[5] various species confined in zoological gardens, maximum 42 years; Townsend,[6] 35 and 40 years.

C. I. REED

UNIVERSITY OF ILLINOIS
COLLEGE OF MEDICINE

RESULTS OF GOITER PROPHYLAXIS WITH IODIZED SALT

WHILE visiting Switzerland Dr. Hans Eggenberger took me all over the canton of Appenzell and allowed me to examine the school children to show the results of 11 years of iodized salt. The results were truly remarkable and perhaps American readers will be interested in the conclusions which Dr. Eggenberger presented to the Second International Goiter Congress at Bern, August, 1933, and communicates to me in a letter.

(1) Iodine in very small quantity is a food.

(2) Of all kryptotrophic elements of the human body, iodine is the first of which we now know the necessary quantity for daily use. This is about 1 or 2 γ for every kilogram of body-weight. (γ = microgram, the millionth part of a gram).

(3) If the average daily intake is under 1 γ/kg. in any part of the world, the danger of goiter in man exists.

(4) If the average intake is near 2 γ there is no danger at all of goiter, even though the susceptibility to goiter is increased by infectious disease or high fat or high cabbage diet.

(5) Experiments to show freedom from goiter without sufficient iodine-supply have often been made without chemical analysis of iodine intake.

(6) The extended natural comparative studies in Switzerland (v. Fellenberg), Holland (Reith) and U. S. A. (McClendon) and the most successful results of prophylactic measures against goiter in Appenzell prove that goiter is indeed a symptom of iodine deficient disease, what Marine, Kimball, Lenhart and others have proved long ago. Goiter can easily be avoided with iodine in the salt, in the proportion of 1: 100,000 for daily use.

J. F. MCCLENDON

UNIVERSITY OF MINNESOTA

SOCIETIES AND MEETINGS

THE NEW ORLEANS ACADEMY OF SCIENCES

THE New Orleans Academy of Sciences held its eighty-second annual meeting at Tulane University on Friday and Saturday, March 15 and 16. The meeting was divided into five sections, at which 39 papers were presented, as follows: Physics, Engineering, Mathematics, Astronomy and Geology, 12; Chemistry, Biochemistry and Chemical Education, 8; Biological Sciences, 9; Medical Sciences, 4; Social Sciences, 6. The total attendance at the section meetings was approximately 550.

On Friday night E. L. Demmon, director of the Southern Forest Experiment Station, U. S. Depart-

[1] R. S. Deck, *Copeia*, p. 179, 1927.
[2] A. P. Medsger, *ibid.*, p. 29, 1919.
[3] E. G. Koch, *Forest and Stream*, p. 170, 1907.
[4] J. T. Nichols, *Copeia*, p. 66, 1917.
[5] S. S. Flower, *Proc. Zool. Soc. London*, p. 911, 1925.
[6] C. H. Townsend, *Bull. N. Y. Zool. Soc.*, Vol. 27, p. 98, 1924.

ment of Agriculture, gave an illustrated public address on "The Social Aspects of Forestry in the South."

The session on Saturday morning was devoted to a symposium on "Stimulation of Scientific Interest at the Level of the High School," under the sponsorship of the recently organized Junior Academy Section of the New Orleans Academy. On Saturday night Dr. A. B. Cardwell, of the Tulane University Department of Physics, gave a demonstration of the properties and effects of liquid air before a large audience of high-school science students, as a part of Junior Academy activities.

The total attendance at all meetings was more than 800.

At the business meeting Dr. Rudolph Matas and Dr. Brandt Van Blarcom Dixon, both past presidents of the academy, were unanimously elected honorary members, by elevation from the rank of regular member. Twenty-eight new regular members were also elected. The officers elected for the coming year are: E. L. Demmon, United States Forest Service, *President;* Dr. H. H. Beard, Louisiana State University Medical Center, *Vice-President;* Philip C. Wakeley, U. S. Forest Service, *Secretary;* Dr. D. S. Elliott, Tulane University, *Treasurer.*

PHILIP C. WAKELEY,
Secretary

THE OKLAHOMA ACADEMY OF SCIENCE

THE twenty-third annual meeting of the Oklahoma Academy of Science was held at the University of Oklahoma, Norman, on December 7 and 8. The academy program was divided into four sections which were as follows: Biology, Geology, Physical Sciences and Social Sciences. One hundred and twenty-two papers were presented. A special section was arranged for high-school science teachers.

Chancellor E. H. Lindley, of the University of Kansas, gave the annual address on Friday evening in the University Auditorium. The subject of this lecture was "Science Confronts Two Worlds." Dr. Lindley spoke again on Saturday morning on "A New Frontier."

Dr. Frank G. Brooks gave the presidential address after the luncheon on Saturday. His subject was "The Place of the Physical and Biological Sciences in the Liberal Arts Curriculum."

More than 300 people were present at the meetings. The officers elected for 1934–1935 were as follows:

President: Dr. C. E. Decker, University of Oklahoma, Norman.
Vice-president, Section A (Biology): Dr. John G. Mackin, East Central Teachers College, Ada.
Vice-president, Section B (Geology): Elmer L. Lucas, Phillips University, Enid.
Vice-president, Section C (Physical Sciences): Mrs. E. S. Hammond, Oklahoma College for Women, Chickasha.
Vice-president, Section D (Social Sciences): Dr. J. T. Sanders, Oklahoma A. & M. College, Stillwater.
Assistant Secretary-Treasurer: Dr. Geo. Van Lear, Oklahoma University, Norman.

HORACE J. HARPER,
Secretary

THE SOUTH CAROLINA ACADEMY OF SCIENCE

THE South Carolina Academy of Science held its twelfth annual meeting at the University of South Carolina on April 6. The meeting was well attended and the secretary reported that the membership of the academy had been doubled within the last two years. The meeting next year will be at Winthrop College, Rock Hill. At the business meeting of the session, the following officers were elected for the ensuing year:

President: Professor Franklin Sherman, Clemson Agricultural College.
Vice-president: Professor A. C. Carson, University of South Carolina.
Secretary-Treasurer: J. E. Copenhaver, University of South Carolina.
Executive Committee: Professor J. A. Osteen, Furman University; Dr. F. W. Kinard, Medical College of South Carolina; Dr. W. W. Rogers, Winthrop College.

J. E. COPENHAVER,
Secretary and Treasurer

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A COMMUTATOR FOR THE HARVARD KYMOGRAPH[1]

A NEED was felt for a dependable circuit breaker that could be attached to a kymograph without necessitating tearing it apart each time it was to be used. Previous attempts at using various makeshift "trigger" attachments led to the construction of the apparatus described here.

In many physiological experiments it becomes desirable to stimulate a preparation at exactly the same location of the drum at each rotation. In others, a key that will be automatically opened or closed on the swiftly moving drum is often advantageous. Also in a great number of routine experiments in which the

[1] From the department of physiology, Purdue University, Lafayette, Indiana.

single throw key is used, the wiring can be simplified by the use of a commutator attached to the kymograph. For example, in the fundamental experiment of determining the phases of a single muscle twitch, the use of the commutator obviates the necessity of the signal magnet to mark the point of occurrence of the stimulus. After the twitch has been recorded on the revolving drum the point where the stimulus entered can be shown quite easily on the same record by turning the drum around to a point just preceding that of entry of the stimulus. Now if the drum is run at its slowest speed until the contact is made, the muscle will again contract and thus mark the point of entry of the make or break shock. Also the arc of the muscle lever will be recorded so that errors due to it can be compensated for on the original record. Thus the commutator simplifies the above experiment by reducing the electrical wiring, eliminating the signal magnet and its additional "scratch marks," and giving a single tracing for the muscle twitch and the occurrence of the impulse, besides picturing the arc of the muscle lever. In many other experiments simplification of wiring and more positive electrical contacts can be produced.

The construction of the commutator is as follows. A brass collar (1, Fig. 1) of slightly greater diameter

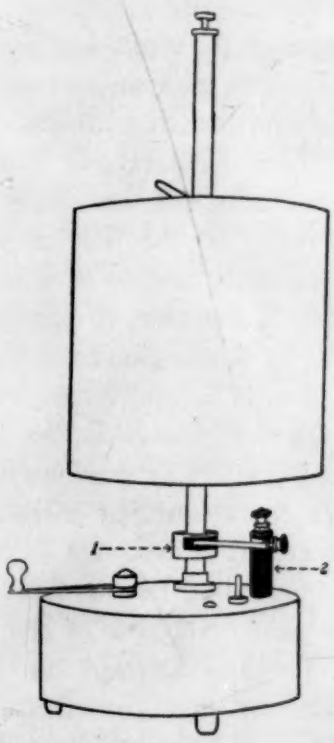

Fig. 1.

than the base of the upright stand is fastened to the shaft of the drum by a countersunk set screw. One half of the circumference of this collar is insulated by an inset piece of bakelite. Then the collar is turned and polished to insure good edges since these are necessary for perfect contacts. All metal parts can be plated to give a more pleasing effect, if so desired. A bakelite binding post (2, Fig. 1) is then mounted in place of one of the three machine screws found on the top of the base of the kymograph. A long machine screw passes into this base and affords the "ground" contact. The upper end of this machine screw is fitted with nuts which hold the post in position and serve as a binding post.

The second contact consists of a strap of brass bound around the bakelite post and making a sliding contact with the collar (1). A slight tension of the brass strip affords a good contact and in no way impedes the turning of the drum. If the commutator is not to be used the bakelite post (2) can be turned slightly to disengage the strap from the rotor. For the sake of simplicity in the accompanying diagram the stop lever and fan have been omitted from the sketch, although they do not interfere with the apparatus in any way.

By varying the position of the secondary coil of the inductorium, threshold make and break shocks can be obtained, and thus one or two stimuli per rotation of the drum can be had at will.

The author acknowledges the assistance of the university technician, W. E. Fish, in the designing and constructing of the commutator.

Wm. A. Hiestand

MENINGOCOCCUS PRECIPITATING ANTIGEN FOR ROUTINE TESTING OF THERAPEUTIC SERUMS[1]

One of the generally used methods of standardizing the potency of anti-meningococcus therapeutic serums is the determination of their precipitating titers. It is therefore necessary to have a highly specific antigen and one that could be kept for a long time without appreciable deterioration. After considerable experimentation with different preparations, the following preparation gave us the desired results.

Meningococcus cultures of standard types are grown on 0.5 per cent. glucose beef-heart agar, pH 7.2 to 7.4. Several successive transplants are made at 24-hour intervals. Then a 24-hour growth is scraped into sterile physiological saline, the suspension is shaken by hand and filtered through a thin layer of sterile absorbent cotton to eliminate particles of agar that may have been carried over. The filtered saline suspension of the cocci is centrifuged at high speed until the cocci are precipitated. The supernatant fluid is discarded and the cocci are suspended in sterile distilled water, using ten times the volume of water to each volume of packed cocci. To this 10 per cent. of commercial antiformin is added and the mixture is placed in boiling water until the cocci are

[1] From the Bureau of Laboratories, New York City Department of Health; Director, Dr. Wm. H. Park.

dissolved—usually 10 minutes. The solution is centrifuged for 30 minutes at high speed, and the clear supernatant fluid is added drop by drop to 95 per cent. alcohol in 50 cc centrifuge tubes using 1 cc of the supernatant fluid to each 20 cc of alcohol; a precipitate forms immediately. The tubes are centrifuged for 5 minutes at low speed, the alcohol is poured off and the tubes are filled with 95 per cent. alcohol which contains 0.2 per cent. HCl. The sediment usually adheres to the sides and bottom of tubes. This should be scraped by means of a pipette and thoroughly mixed with the acid alcohol; care should be taken to break up large clumps. This is centrifuged for 5 minutes, the acid alcohol poured off and the sediment washed twice in 95 per cent. alcohol, using the same procedure as above. After the final washing, the alcohol is drained off and the sediment dissolved in saline, using 10 times the amount of the original packed cocci. The sediment dissolves readily in the saline, and in order not to lose any of the sediment, the necessary amount of saline is added to the centrifuge tubes. The solution is then collected and placed in sterile centrifuge tubes and heated in boiling water for 20 minutes. It is then centrifuged for 30 minutes at high speed and the clear supernatant fluid collected aseptically into small sterile vials and stored in the ice box.

The antigen is standardized by testing with known homologous and heterologous serums, using various dilutions of the antigen and the optimum dilution of the antigen is determined by repeated tests. This dilution is then used as the standard dilution for the routine testing of the antimeningococcic serums.

The antigen can be kept almost indefinitely when stored at 8 to 10° C. Care should be taken not to contaminate it. We have been using antigens prepared according to this method for the past several years in testing our therapeutic serums, also to follow the response of the horses during the process of immunization, and found the antigens stable and highly specific.

LUCY MISHULOW

SPECIAL ARTICLES

INVESTIGATION OF OVERTHRUST FAULTS BY SEISMIC METHODS[1]

IN the great mountain belts the earth's crust has been severely buckled and fractured, apparently mainly by horizontal compressive forces. Of the various types of folds and faults that developed in the course of this deformation the enormous overthrust faults are among the most important and interesting. Along these horizontal or gently sloping fractures huge slabs of the crust ranging from thousands of feet to miles in thickness have been thrust forward for distances of miles and sometimes for many tens of miles. The length of these faults, traced along the surface, is from tens to hundreds of miles. Their extension backward and downward into the crust is presumably of comparable dimensions, but in view of the limited thickness of that part of the crust which has suffered mountain-making deformation, it is unlikely that the depth to which they reach exceeds a few tens of miles. On our own continent the Rocky Mountains of the northern United States and of Canada have been thrust many miles eastward over the margin of the Great Plains along such overthrust faults. In the southern Appalachians each of the several slabs shown in any cross section has ridden westward over its neighbor. In the Alps and in the Highlands of Scotland overthrusts on a tremendous scale have been recognized.

Until the shape of the fault surfaces is known it will be very difficult to gain an understanding of the mechanics of the overthrusting process. Suppositions regarding their form have ranged from convex upward to concave; Longwell has suggested that the presumable convexity of the portion near the trace may change to concavity farther back under the plate. It has been difficult, however, to ascertain the three-dimensional form of these remarkable structures, since observation of them is limited to the trace—the intersection of the fault surface with the land surface—and to occasional fensters or windows where a stream has cut through the overriding plate to expose the undermass. Clearly it is desirable to gain any information possible regarding the shape of the fault surface, or of any part of it back of the trace. So far as known, no previous attempt has been made to secure such data for great overthrusts by utilizing seismic reflections. The experiment was tried only after several years' experience with the method and after considerable success through its use had been attained in determining folded structures in stratified formations.

Elastic waves in the crust of the earth are reflected when they encounter a surface between two layers or bodies in which the waves are propagated at different

[1] Contribution 164 of the Balch Graduate School of the Geological Sciences, California Institute of Technology, Pasadena.

velocities. In most applications of seismic methods to stratified rocks the velocity in the layer above the reflecting surface is lower than that in the layer below it, but in the case of great overthrusts the velocity in the upper layer is usually the higher.

Individual strata a few feet or even a few tens of feet in thickness do not reflect the waves; a layer must be about a wave-length in thickness, *i.e.*, of the order of 100 feet, to cause strong reflection. Only if the instruments are located a long distance from the shotpoint does less reflected energy reach them when the high-velocity rock is on the upper side of the reflecting surface.

As a consequence of the usually reversed velocity relation in overthrust plate and undermass, waves passing the boundary surface into the undermass of lower velocity are *refracted* back toward the surface only at distances too great for observation. Consequently, it is usually not possible to utilize the so-called *refraction* method for the investigation of the thickness of overthrust plates. The *reflection* method is effective in this case, however, for the intensity of a *reflected* wave, if its path meets the boundary surface approximately at right angles, differs but little whether it encounters that surface from the high velocity or the low velocity side.

Nature of Method Used

The underlying principle involved in the reflection method is, of course, the precise measurement, to the nearest one thousandth of a second, of the time required for the passage and return of an elastic wave or miniature earthquake, produced by detonating a charge of dynamite, from a reflecting surface in the crust. Knowing the velocity of the wave in different media, the distance or depth to that surface can be calculated. In soft formations the charges are usually fired in holes about 40 feet deep, since at less depth a large part of the energy is dissipated into the uppermost layer and into the air, causing surface waves and atmospheric sound waves which unduly disturb the instruments. Overthrust plates are commonly so hard, however, that surface-waves are not produced. Moreover, 40-foot holes can not easily be drilled into them, and in the experiments herein described the dynamite was fired in holes not exceeding a few feet in depth. The distance between the shotpoint and the instruments and the amount of dynamite must be such that neither the direct waves through the uppermost layer nor the sound wave interfere with the recording of the reflected waves. Usually the distance was so chosen that the reflected waves arrived either in the interval between the arrival of the direct waves and the sound wave, or shortly after the sound wave.

Beartooth Overthrust

The first attempt to measure the thickness of an overthrust plate was made in July, 1934, on the Beartooth Plateau in northwestern Wyoming and south-central Montana, roughly 12 to 20 miles southwest of Red Lodge, Montana, along the new Red Lodge-Yellowstone Park highway. The experiment was carried out as part of the Yellowstone-Beartooth-Bighorn project initiated by Dr. W. T. Thom, of Princeton University. The funds which made the test possible were made available by the Geological Society of America. Only one day was available for the experiment.

The Beartooth overthrust plate consists of old crystalline rocks, granitoid in character at the localities occupied and locally somewhat gneissic. Flattish-topped, the Beartooth Plateau descends rather suddenly on its eastern side to the trace of the bounding overthrust fault which separates the overthrust plate from the over-ridden block. The surface parts of the latter are composed of Paleozoic and younger sedimentary formations.

Charges were fired and records made at three localities, at each of which different shotpoints, charges and distances between shotpoint and instruments were utilized.

The very first seismogram recorded not only a very definite reflection from the overthrust fault surface but also reflections from underlying strata. Using a velocity of 5.5 km/sec, calculated from the direct waves between shotpoint and instruments (maximum distance 337 meters) the thickness of the overthrust plate was found to be about 3,300 meters (10,800 feet). Similarly, at the second point the thickness was determined to be about 2,500 meters (8,200 feet), and at the third point the depth below the surface was about 2,100 meters (6,900 feet). The data appear to agree very well with such geologic facts regarding the fault as can be observed at the trace.

Frazier Mountain Overthrust

A second test of the seismic reflection method for determining the thickness of overthrust plates was made on Frazier Mountain during three days of field work in November, 1934. The mountain rises immediately west of Tejon Pass, where the Sierra Nevada joins the Coast Ranges of California, about 90 miles northwest of Los Angeles. Its east-west length is about 8 miles, its north-south width about 4 miles, and the elevation of its broad flat top is between 7,000 and 8,000 feet. The upper parts of the side slopes are precipitous.

The geological mapping of the Tejon Pass region by field parties from the California Institute of Technology had previously revealed that the structure of the mountain is most unique. The entire upper part consists of old crystalline intrusive and metamorphic rocks. These extend down the north slope to the San Andreas fault at the foot of the mountain. But for more than three quarters of its periphery Tertiary beds form the lower slopes, and the contact line between the Tertiaries and the crystalline complex roughly parallels the contour lines. In one excellent exposure the contact is horizontal. These and other evidences led to the interpretation that Frazier Mountain is an overthrust slab of old crystallines on Tertiaries—a mountain without roots. It seemed desirable to ascertain if possible the thickness of the slab at a few points by seismic methods. Here, again, are rocks of high wave velocity lying on others of low velocity.

Four instruments stations were occupied, of which the first was used primarily to determine optimum distances between shotpoint and instruments and the proper dynamite charges. The other three stations were on a north-south line, one near the south edge of the mountain top, another near the north edge and the third in an approximately median position.

After some experimenting at each point the travel times of the reflected waves were found to be 0.265 second at the southern point, 0.24 second at the middle point and 0.34 second at the northern point. The velocities in the uppermost layer and its thickness differed considerably at the three localities, but the value of 4.1 km/sec, derived from the longest refraction profile (1,087 meters) shot at the northern point to secure velocity data, was used at all three points for all but the uppermost layer, to which the lower local velocities were applied. On the basis of the above data the thickness of the overthrust plate was calculated to be about 370 meters (1,200 feet) at the southern point, about 430 meters (1,400 feet) at the middle locality and about 580 meters (1,900 feet) at the northern point, with a possible error of a very few hundred feet caused by inadequate velocity data. Subtracting these thicknesses from the surface elevations, about 7,700 feet at all three points, the corresponding fault surface elevations are 6,500, 6,300 and 5,800 feet. The distance between the north and south points is about 8,800 feet and the average north-south component of the dip of the fault surface is therefore about 5° toward the north. The data also indicate that the average dip steepens toward the north. The seismic results agree as well as could be expected with our geological knowledge derived from study of the periphery of the mountain.

Conclusions

The investigations clearly demonstrate that it is possible to measure the thickness of overthrust plates by use of the seismic reflection method, and from a number of such measurements to determine the form of the fault surface.

Since the method depends upon difference in the elastic constants of the rocks above and below the fault surface, it is applicable not only to those cases in which soft young low-velocity strata overlie or underlie bodies of old crystalline high-velocity rocks but also to those cases in which old crystalline rocks occur both above and beneath the fault surface, provided the velocities above and below differ materially. Since velocities in different intrusives and metamorphics do vary considerably, and since quite different crystalline rocks are brought together along overthrust surfaces due to the great displacements, there is good probability that in favorable cases the surfaces can be followed back from the fault trace to much greater distances than the rear margin of the overridden soft sediments.

The method can not be used successfully on those parts of overthrust surfaces which separate rock bodies in which elastic wave velocities are nearly equal, because the fault itself does not reflect the waves. Also, since the thickness of fault gouge and breccia is usually considerably less than a wavelength, these materials can not be expected to serve as effective reflectors.

However, the maximum distance back from the fault trace to which reflections can be secured gives a minimum extent for the fault surface. It is quite possible that if reflections can be recorded again at localities more distant from the trace than intervening futile points the fault surface can once more be identified and perhaps corroborated by backward projection of the dip determined from the points nearer the fault trace and forward projection of the dip derived from the more distant points.

The experiments indicate that the amount of dynamite needed per charge in the old crystalline rocks is generally very small. The best results were secured with charges ranging from a fraction of a pound to a very few pounds. These quantities contrast with the 20 to 40 pounds per charge required in our recording of reflections from depths approaching 45,000 feet in the soft Tertiary and presumably older sediments of the Los Angeles basin. In shooting on old crystalline rocks deep holes are not needed. For most effective operation a crew of about seven men is desirable.

JOHN P. BUWALDA
BENO GUTENBERG

DISTRIBUTION OF MITOCHONDRIA IN THE FORAMINIFERAN, IRIDIA DIAPHANA

It has been occasionally noted[1,2] that the mitochondria in a cell are arranged in greatest numbers at the locus of interchange of metabolites between the cell and its environment. A review of the morphology of glandular cells[3] reveals that mitochondria are most numerous in the basal regions of such cells and that it is in these regions that metabolites are absorbed. Doyle has carried this a step further to suggest that in *Amoeba* the mitochondria function as transportive elements within the cell.

The structure of *Iridia diaphana* is significant in this regard. The organism is abundant on *Posidonia* (turtle grass) at Dry Tortugas, Fla. It is an arenaceous form which is particularly adapted to cytological research because it frequently leaves its shell and crawls about naked.

The cytoplasm contains a large nucleus, numerous golden or reddish oil droplets 2 to 5 micra in diameter, many colorless carbohydrate spheres 3 to 6 micra in diameter, numerous minute calcium oxalate crystals not over ½ micra long, and ovoid mitochondria which average ¾ micra in length. The crystals and the mitochondria are the only structures which might be confused with each other because of their size and appearance. They are readily differentiated in the living condition by means of polarized light. The crystals are brilliantly optically active, whereas the mitochondria are not noticeably so.

In the central protoplasmic mass, from which myriads of anastomosing filamentous pseudopodia extend, there are many currents of streaming protoplasm constantly in action. These currents frequently lead to the bases of pseudopodia at which points only the mitochondria flow out into the hyaline cytoplasm. The mechanism whereby the constituents are segregated so that only the mitochondria leave the central mass when there are other equally small bodies present which never do is entirely unknown. The mitochondria, which are frequently larger in cross section than the cross section of the pseudopod, flow out into the pseudopodia and in so doing meet and pass other mitochondria which are returning to again mingle with the other cytoplasmic constituents of the central mass.

Whatever the rôle of the pseudopodia; whether elimination of waste products, absorption of food or as contractile elements; they are always liberally supplied with mitochondria, and mitochondria are the only formed bodies in them. Conversely, whatever the rôle of the mitochondria, their presence in the pseudopodia gives them ample opportunity for the interchange of substances with the surrounding medium.

Wm. L. Doyle

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[1] Horning, *Austral. Jour. Exp. Biol. and Med.*, 2–5, 1925–28.

[2] Doyle, Dissertation, The Johns Hopkins University. In press.

[3] Bowen, *Quart. Rev. Biol.*, 4: 1929.

DIRECT ISOLATION OF PASTEURELLA-LIKE MICROORGANISMS FROM BRAINS OF HORSES SUFFERING FROM SO-CALLED CORNSTALK DISEASE

In a recent note in Science[1] mention was made of the isolation of pasteurella-like microorganisms from the brains of seven horses that succumbed to so-called cornstalk disease in different counties in Illinois. These isolations were made following death of guinea pigs, pigeons and rabbits inoculated subcutaneously with horse brain tissue suspended in sterile physiological sodium chloride solution, as well as saline suspensions of mixed aerobic cultures from brains of naturally infected horses. For the reason that laboratory animals may harbor pasteurella and, following death from a variety of causes, yield positive cultures, the brains of horses dying from so-called cornstalk disease were cultured on different media to appraise the part laboratory animals might play in the positive pasteurella isolations following inoculation with horse brain tissue and mixed cultures from horse brain suspended in saline.

Each horse supplying brain tissue included in direct cultural studies, as in aforementioned studies, displayed a spontaneous encephalitic syndrome. The affected horses originated on different farms over a territory extending from north-central Illinois south more than 150 miles to the south-central district of the state, including Will, Iroquois, Champaign, Christian, De Witt, Douglas and Montgomery counties. The horse brains were delivered to the laboratory in from one to six hours following humane destruction or death from so-called cornstalk disease. Immediately on arrival the encephalon was removed from the cranium and the meninges dissected from the brains. Small pieces of the brain tissue were seeded in tubes of pork and beef meat mash broth. The inoculated tubes were allowed to incubate for three to six days at 37° C. Gentian violet agar plates were then streaked from the meat mash cultures with a platinum loop. Colonies resembling pasteurella developing along the line of inoculation were picked on 10 per cent. horse blood agar slants for identification.

From eight different horse brains pasteurella-like microorganisms were isolated by direct cultural methods. Similarly streaked cultures of the meat mash horse brain cultures on plain and blood agar plates were invariably overgrown with a variety of uniden-

[1] Science, 81: 2093, 153, February 8, 1935.

tified bacteria, including gram positive rods, *E. coli*, streptococci and diplococci, as well as actinomyces, aspergilli and other unidentified molds.

ROBERT GRAHAM

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ERGOTOCIN

IT has been found by the authors, working in conjunction with Drs. Davis, Adair and Rogers, of the Department of Obstetrics and Gynecology of the University of Chicago, that the alkaloids ergotoxine, ergotamine, sensibamine are uniformly ineffective when administered orally to human mothers in doses of 2 mg. Larger doses (2–4 mg) often induce unpleasant side reactions such as nausea, vomiting, increase in blood pressure, diarrhea, etc. However, even these large and dangerous doses do not induce contractions in the eighth-day postpartum uterus, in all mothers. While the number of cases studied by us is relatively small (15 cases) these large doses of the alkaloids were found effective only in about 30 per cent. of the cases.

We have found, however, that some fluid extracts of ergot, prepared in accordance with U. S. P. method, were effective in doses corresponding to 3–4 gm of ergot. The activity of these extracts could of course not be due to the known alkaloids (the amounts of these alkaloids as assayed by us were too small to account for the activity), and we undertook the problem of the isolation of the principle responsible for the efficacy of oral ergot dosage. While preparations containing from 60 to 80 per cent. of this principle were obtained by us over a year and one half ago, the isolation of the pure crystalline substance was made only on December 12, 1934. We have called this principle ergotocin. In human mothers this substance is uniformly effective when administered orally in doses of 0.3 mg and intravenously in doses as low as 0.1 mg. The yield of 0.3 mg of ergotocin is roughly equal to from 3 to 4 gms of crude defatted ergot. This principle thus accounts for the activity of the fluid extracts.

Ergotocin has now been used on over 150 patients and no unpleasant symptoms have been observed with it. It controls uterine hemorrhage instantly. Intravenously the effect is noticed within 15 seconds after administration. In the first stages the action of ergotocin resembles that of pituitary extracts, except that its effect lasts for 3 or 4 hours, in marked contrast to the transient effect usually obtained with pituitary extract. In its low toxicity, small dosage, prompt action in uterine hemorrhage, prolonged effect on the uterine muscles, ergotocin is unique among oxytocic principles.

Ergotocin salts, as well as the free base, are white, well-defined crystalline substances. The base melts with decomposition at 155°. The picrate, which is red, melts at from 195 to 197°, with decomposition. The free base is somewhat soluble in water, and the salts are readily soluble. One may obtain even a 10 per cent. aqueous solution of some salts of ergotocin, a unique property among the alkaloids isolated from ergot. Ergotocin differs from the known ergot alkaloids (ergotoxine, ergotamine, sensibamine) in that it is not precipitated by Meyers's reagent in dilutions greater than 1 part in 7,500, while the other alkaloids are precipitated in dilutions of 1: 200,000, to 1: 2,000,000. The optical rotation of the salts of ergotocin so far investigated is positive. The chemistry of ergotocin as well as some of the attempts to synthesize it will be reported as soon as the work now under way is complete.

We believe that with the isolation of this principle ergot therapy can now be put on a rational basis. If one bears in mind that many ergots do not contain this principle (and yet are acceptable on the basis of the U. S. P. assays), the cause of the difference of opinion among obstetricians regarding the value of ergot in obstetrics becomes evident.

The authors wish to take this opportunity to thank most sincerely the Research Corporation, Inc., for a grant which made this work possible and the Eli Lilly Company for generously aiding us in this investigation.

Needless to say, without the cooperation and constant guidance of Drs. Davis, Adair and Rogers, on the clinical and pharmacological evaluation of this principle, this work would not have been brought to a successful conclusion.

M. S. KHARASCH
R. R. LEGAULT

GEORGE HERBERT JONES CHEMICAL LABORATORY
THE UNIVERSITY OF CHICAGO

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